completely satisfied, the work may fairly be regarded as the mature expression of his deliberate thought on the subject.

The book opens with a preface by Helmholtz, followed by the author's preface; then there is an introduction, and the author's theory is formulated in two books:—Book i.: Geometry and kinematics of material systems; Book ii.: Mechanics of material systems. Helmholtz's preface contains an account, which might be called an appreciation, of the scientific work of Hertz, and is further remarkable for the statement that, while Kelvin, Maxwell and Hertz appear to have derived fuller satisfaction from explanations of physical facts founded on some simple general conception, such as Hertz's "straightest path," he, for his part, had felt safer in adhering to the representation of physical facts and laws by systems of differential equations. In his own preface the author tells us that his object was "to fill up the existing gaps, and to give a complete and definite presentation of the laws of mechanics which shall be consistent with the state of our present knowledge, being neither too restricted nor too extensive in relation to the scope of this knowledge"; and that what he hoped was new in his work was "the arrangement and collocation of the whole—the logical or philosophical aspect of the matter."

In the introduction the author criticises the received theory of dynamics and the more modern doctrine of energetics, and proceeds to explain the character of the new theory which he proposes. The novelty consists in this: whereas the other two theories started from four fundamental concepts—space, time, mass and force, or energy—he requires only three—space, time and mass—and the hypothesis of concealed masses. In Book i. relations concerning spaces and times are considered, and we have a generalisation of ordinary kinematics, including definitions of the path and velocity of a material system, and its shortest and straightest paths. By a material system is meant what in the ordinary presentation of dynamics would be called a system of particles with invariable connections. Some of the definitions referred to contain arbitrary elements, but they are, at any rate, simple. The definition of *mass* might have been omitted with advantage. In Book ii. the author enunciates his "fundamental law"—that every free system moves in a straightest path. This law may be looked upon as an interpretation of the principle of least action for systems of which all the energy is kinetic, or as an extension of Gauss's principle of least constraint. He proceeds to show how the motions of systems which are not free can be brought under the fundamental law by means of the hypothesis of concealed masses—the visible system is regarded as linked on to another system by invariable connections—and it is proved that the equations of motion of the system contain terms which correspond to the "forces" of ordinary dynamics. It is, perhaps, not remarkable that the dynamics of distant gravitating bodies, which was the immediate object of the received theory, should offer special difficulties from the present point of view (§ 469); on the other hand, it is claimed that the new minimum principle is applicable to invariable connections of the type of pure rolling, in which the velocities are connected by non-integrable equations, and that it thus includes more phenomena than the principle of least action. A considerable portion of Book ii. is taken up with the consideration of cyclical systems. Hertz has here developed important conceptions due to Helmholtz. Throughout both books the "older synthetic method," that of a chain of propositions, has been adopted in order that the logical purity of the theory might be beyond dispute.

Whatever may be the influence exerted on the progress of mechanics by Hertz's kinematical generalisations and fundamental law, there cannot be any doubt of the value of his criticisms of existing dynamical theories. He has explained, in the clearest manner, the object of physical theories, and stated the conditions which such theories must satisfy. He has tested the received theory of dynamics—that which is associated with the names of Galilei, Newton, d'Alembert and Lagrange—in respect of logical permissibility, and in respect of appropriateness as an expression of facts. Concerning this representation of physical experience, he asks: "Is it perfectly distinct? Does it contain all the characteristics which our present knowledge enables us to distinguish in natural motions?" And his answer is "a decided—No." He has put his finger on the weakest part of the theory—the relation of the notion of internal stress to that of equal and opposite distance-actions. He makes the supposition that the theory can, even here, be rendered rigorous, and prefers to base his attack on the complexity of the various actions which the theory needs to assume. In a somewhat similar spirit he discusses the representation of physical facts by means of the theory of energy, although it is rather the logical permissibility than the appropriateness of this representation that is called in question.

The translators have done their work well on the whole. Here and there they have been too literal, or not literal enough; they have left some obvious misprints in the German text, and some in the translation, uncorrected; but these are slight blemishes, and we must be grateful to them for a rendering which admirably conveys the spirit of the original. Their translation should serve to make more widely known a book which certainly ought to be read by all who wish to have clear ideas concerning the most fundamental of the physical subjects. A. E. H. L.

ASSYRIAN AND BABYLONIAN ASTROLOGY.

The Reports of the Magicians and Astrologers of Nineveh and Babylon. By R. C. Thompson. Vol. i. Pp. xviii + 85 plates of cuneiform text. Vol. ii. Pp. xci + 148. (London: Luzac and Co., 1900.)

IT is now about thirty-five years ago since the late Edward Hincks, whose name will be honourably coupled with the history of cuneiform decipherment, astonished many folk by declaring that he had discovered in the British Museum tablets which related to the pseudo science of astrological astronomy. And it is not surprising that such a declaration evoked general interest, because reasonable grounds existed for hoping that when the texts on the tablets had been deciphered, some trustworthy information about Chaldean astronomy might be forthcoming. The labours of Hincks were followed by those of Lenormant and Oppert, but they had little

result, because neither of these scholars was able to devote sufficient time to the study of original texts in the British Museum. Great impetus was given to the study when the late Sir Henry Rawlinson published the third part of the "Cuneiform Inscriptions," and Prof. Sayce found therein material for his paper on the "Astronomy and Astrology of the Babylonians," which appeared in 1873. During the last twenty-five years the astronomy of the Babylonians has been discussed by Strassmaier, Jensen and others, but little has been done for the older, sister subject of astrology. In the two volumes before us Mr. Campbell Thompson gives us the cuneiform text of what is, practically, the complete series of the Astrological Reports of the Royal Library at Nineveh—that is to say, copies of about two hundred and eighty tablets, and transliterations of about two hundred and twenty duplicates, without reckoning the transliterations of the texts of the original series. In addition, we find a translation of the tablets in English, and a vocabulary, with references, and a subject index. The work in each of these sections has been carefully done, and we welome Mr. Thompson in the little band of English Assyriologists, because his pages, somehow, suggest that he intends to try to justify his position as assistant in the British Museum. The study of Biblical parallels and the making of Biblical comparisons are interesting and useful enough in their way, but it is useless to dogmatise about any branch of Assyriology as long as the literature relating to it remains unpublished. Mr. Thompson's book is a good proof of this contention. Many have talked glibly and written vaguely about Chaldean astrologers, but now that we have before us the actual texts of the documents which they drew up, we shall find that most of what has been written on the subject before is incorrect.

The study of astrological astronomy in Western Asia is very ancient, and an old tradition, referred to by Pliny, states that the Babylonians possessed records of calculations which covered a period of 490,000 years; there is no doubt that we now possess texts of this class which are as old as the reign of Sargon of Agadhe (about B.C. 3800); but nothing older than this date has yet been unearthed. The principal astronomical schools in Assyria in the seventh century B.C. were at Ashur, Nineveh and Arbela, and at a later period Sippar, Borsippa and Orchoe, in Babylonia, were famous for their schools. The chief duty of the astrologer in Assyria was to calculate times and seasons, which he did either by observation or by the help of an instrument called *abkallu shikla—i.e.* "master of measure" (*or* reckoning). This instrument may be the clepsydra, which Sextus Empiricus says was known to the Chaldeans. The time measure was called *kasbu*, and contained two hours; the month was one of thirty days, and the year contained twelve months. The Assyrians employed one intercalary month (second Adar), and the Babylonians two (Elul and Adar). Both nations had a year of lunar months, and much of the time of the Chaldean star-gazer was spent in observing the sun and moon, with the view of determining when the months began and ended. The seven planets were called Sin (moon), Shamash (sun), Umunpauddu (Jupiter), Dilbat (Venus), Kaimânu (Saturn), Gudud (Mercury), and Mushtabarrû-mûtânu (Mars). From these, and the Signs of the Zodiac, and indeed most heavenly bodies, omens were deduced, and from the horns of the moon many portents were derived. Another source of omens were the halos, two of which were known; the one was of 22°, and the other of 46°. Dark halos always portended rain, and were well known, and Mr. Thompson suspects that the astrologers were acquainted with mock suns also. That they were good weather prophets is tolerably clear from many indications; indeed, it would be surprising if they were not. The omens derived from eclipses are very interesting, but the train of reasoning which guided the composition of birth portents cannot always be followed. Thus, in text No. 277, it is related that a certain butcher, called Uddanu, reported to an astrologer that when his sow littered, one of the young pigs had eight legs and two tails, and that he had preserved the animal in brine; from this birth the astrologer deduced the omen that the Crown Prince of the day would "grasp power." But why? Many of the reports sent to the king are interesting, chiefly because of the variety of their contents. When the astrologer had reported the astrological fact asked for, he added any little detail concerning mundane affairs which he might have room for on the tablet, or which he thought it would amuse the king to have knowledge of. Sometimes there is nothing of special astrological importance in the report at all—*e.g.* No. 22, whereon the writer wishes the king power and riches, and says that as the gods Ashur, Shamash, Nebo and Merodach have delivered Kush and Egypt into his hands, even so will they deliver the Cimmerians and the Mannai. Again, in No. 124, more than one-third of the report is occupied with the discussion of some private affair, in which the writer says, "Now the king knows I hold no land in Assyria." From the literal translations which Mr. Thompson gives in the second volume of his book, it is clear that the writers of these reports wilfully obscured their meaning by using obscure and difficult words, and that they intended to make it necessary for their recipients, royal or otherwise, to call in the professional astrologer. If the Assyrians found it difficult to get out a meaning from such documents, there is small wonder that we, in these days, have a difficulty in understanding them also, and as many of the allusions must necessarily be unknown to us, we may have to wait for new texts which will help us to clear them up. Meanwhile, Mr. Thompson has dealt carefully with his texts, and has erred rather on the side of being too literal than too paraphrastic in his translations. It is to be hoped that he will find time to continue his investigations, and to give us accurate editions of original documents, which may serve as the foundation of a superstructure of facts rather than theories.

THE SCIENCE OF NUMBER.

Éléments de la Théorie des Nombres. Par E. Cahen. Pp. viii + 404. (Paris: Gauthier-Villars et Fils, 1900.)

TO the contemplative mind the science of arithmetic offers irresistible, if tantalising, attractions. The abstract notion of number underlies all scientific knowledge and theory whatever; and it is in terms of it alone that we are compelled to seek for the ultimate statement of the facts of the sensible world. It is most unfortunate